MINISTRY OF TRANSPORTATION

RoadTalk

Ontario's Transportation Technology Transfer Digest • Winter 2008 • Vol 14 Issue 1

Gearing Up For Winter

Winter Maintenance Technology

The air blade plow blows compressed air onto the pavement, breaking up packed snow in wheel tracks.

Ontario's Ministry of Transportation (MTO) is committed to a high standard of safety on provincial roads and highways during the winter months. With that in mind, MTO has a program that develops a wide range of winter maintenance technologies to help remove snow, prevent ice, and predict conditions and areas that require extra attention during winter events. Look for future Road Talk issues, as we profile some of the innovative winter maintenance technologies being introduced, tested and implemented by MTO, including:

1. **Alternate Plow Blade Designs:** MTO continues to test innovative plow blade designs, including air jet plows, tow plows, and dual-blade plows. These designs are intended to reduce blade wear, minimize wheel tracking, reduce the amount of road salt necessary, and increase safety by improving the overall quality of snow removal.
2. **Anti-icing liquids with corrosion inhibitors:** Winter maintenance liquids have been used by MTO for several years to complement winter road salt in preventing and clearing ice on roads and highways, both by pre-wetting road salt as it is being applied, and by directly applying liquid solutions to the road surface in advance of a winter event (Direct-Liquid Application). Standards require that corrosion inhibitors must be added to anti-icing liquids to make them at least 70% less corrosive than rock salt. MTO is currently conducting tests to determine whether these corrosion inhibitors are working as intended, and whether a 70% reduction in corrosiveness over rock salt is an appropriate target level. In the study, a series of metal coupons will be attached to winter maintenance vehicles, and their corrosion will be measured over the course of a winter season.
3. **Next Generation RWIS:** There are currently 113 Road Weather Information System (RWIS) stations across Ontario that monitor current conditions and provide site-specific forecasts to help predict road surface conditions. This helps patrol staff decide when to plow, salt, or sand highways, and how much material to use. MTO has begun planning next generation RWIS, incorporating Maintenance Decision Support Systems (MDSS) and other advanced technologies to more accurately and easily diagnose, detect, and display »

Road Talk is prepared and published triannually by the Division Services Office, Provincial Highways Management Division, Ontario Ministry of Transportation. Road Talk is distributed electronically in both PDF and HTML forms and is available at:
www.mto.gov.on.ca/english/transtek/roadtalk

Road Talk est aussi disponible en français:
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This publication reports on innovations and new technology relating to highway management; the design, construction, operation and maintenance of highway infrastructure.

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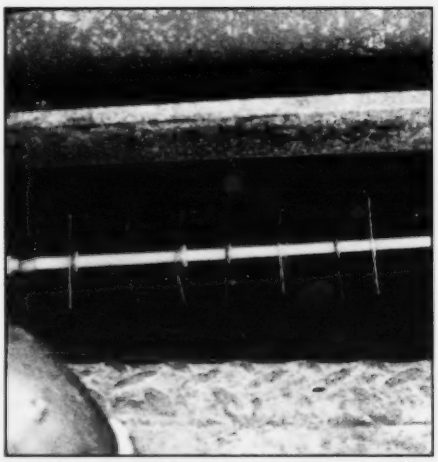
> weather information, road condition information, and maintenance treatment recommendations.

4. **Using RWIS to Trigger Spring Load Restrictions:** MTO places load restrictions on surface-treated highways in northern Ontario to protect road surfaces and foundations during the spring thaw. Traditionally, restrictions are set and removed on the subjective basis of fixed calendar dates, with adjustments based on local experience. MTO is currently developing an objective system, using RWIS data, engineering models, and forecasts to provide advanced warning of restriction dates based on the estimated depths of frost and thaw. This will maximize road longevity and provide additional rationale for the timing of restriction periods.
5. **Hot Water Sanding:** MTO is performing trial investigations of hot water sanding for snow-packed, low-volume highways. In hot water sanding, a mixture of hot water and sand is deposited on snow-covered roads in advance of traffic. As the mixture hits the ground, it freezes and gives the road surface a sandpaper-like consistency. In Scandinavian trials, the mixture was found to provide better traction on icy roads for several days.
6. **Friction Studies:** Traditionally, snow removal is performed until bare pavement has been achieved, as monitored by road patrollers. However, MTO has started examining the possibility of developing alternative methods for monitoring service levels. One of these is based on road friction. Early trials show a quantitative link between friction and road surface conditions, as measured between bare and snow or ice covered roads. In the future, MTO will address the possibility of using friction studies to improve maintenance practice and evaluate maintenance service.
7. **Cooperation with other agencies:** MTO's programs are coordinated with the research of a number of other road and highway agencies, including the Transportation Research Board, TAC, and the AURORA Program. The AURORA Program, for example, is a pooled fund program that includes transportation agencies, universities, and weather services across the United States, Canada, and Europe with the shared goal of improving road weather information systems.

This issue of Road Talk features an in-depth look at alternate plow blade designs. ●



Metal coupons affixed to a winter maintenance vehicle test the effectiveness of corrosion inhibitors.

For more information, please contact Max Perchanok, Research Coordinator, Higway Standards Branch, at (416) 235-4680 or Max.Perchanok@ontario.ca

Next generation RWIS sensors detect pavement contaminants, including snow, frost, ice, and slush.

Old Tires, New Highways: Rubberized Asphalt Pavement

MTO is always examining innovative materials and technologies to extend the longevity of Ontario's roads and highways while decreasing the environmental impact of construction. For this reason, MTO has planned trials of rubberized asphalt on a 15 km stretch of Highway 15, between Smiths Falls and Lanark Road 10 in Eastern Region. Two trial sections using rubber will be among those constructed along the stretch of highway, in an attempt to localize trials in a single area for ease of monitoring.

Scrap tires have been used in asphalt pavement since the early 1980s, developed primarily as a way to mitigate the considerable environmental impact of waste tires. Such tires are often home to pooled water that creates a breeding ground for mosquitoes and other insects. They are also at risk for tire fires, which pollute the air and ground. Rubberized asphalt turns a source of waste into a useable commodity, reducing the number of tires in storage and mitigating these concerns.

Rubber asphalt is produced by one of three methods. In the dry process, crumb rubber is added into the Hot Mix Asphalt (HMA) during the mix process, as an aggregate product. The amount of crumb rubber introduced into the mix determines the degree of modification to the HMA. In the wet process, very fine crumb rubber is blended with the asphalt cement (AC) producing a rubber modified AC that is used in the HMA. This process requires a blending unit capable of properly metering crumb rubber into the AC in the required proportions. Additionally, tanks must be specially equipped to properly digest the rubber crumb in with the parent asphalt cement. The semi-wet or moist process lies somewhere between the wet and dry processes. Very fine rubber crumbs are added to the mixer just prior to the addition of asphalt cement. A longer mixing time is required than for normal HMA to allow for some reaction between the crumb rubber and AC, resulting in partially modified asphalt cement. The addition of rubber to the mix using this semi-wet process is easier than either the dry or wet processes, and has the potential to improve the performance of the asphalt pavement.

While rubber asphalt is generally 15 to 20 percent more expensive than conventional asphalt mixes, it does have benefits. When produced by the dry process, rubberized asphalt is generally less prone to cracking and may also reduce road noise, making it ideal for bike and walking paths. A survey of pavement performance in Ontario, however, indicates that use of the dry process is not appropriate for heavily trafficked roads.

Used as a modifier via the wet or semi-wet processes, rubber has a number of benefits over traditional polymers: it results in asphalt cement that is thicker and more viscous, producing an HMA with more coating on the aggregates, which normally results in better durability. A draft ministry report recommends that trials proceed using the wet or semi-wet process, rather than the dry process.

In the rubber asphalt trials, two sections will be constructed using the semi-wet process. The first trial will use cryogenic ground rubber and the second will use ambient ground rubber. Cryogenic ground rubber involves freezing scrap rubber with liquid nitrogen before grinding. Subsequently, the rubber shatters when an impact is applied, producing particles with clean, smooth surfaces (see Figure 1). Ambient ground rubber is ground at room temperature or above, and has a high surface area (see Figure 2) that reacts with asphalt cement more quickly. The trials will determine whether cryogenic or ambient ground rubber provides better quality rubber asphalt.

Gary Shaw, Director of Transportation and Public Safety in Grey County, has been a vocal champion of rubber asphalt in Ontario. In the early 1990s, Shaw spearheaded an effort to recycle old tires into repaired roads, using the dry, wet, and semi-wet processes. Grey County's success with these processes has been attributed to their precise quality control over a Closed Loop Recycling program that begins with tire rubber recovery and ends with the placement of rubber asphalt on municipal roads. Because of cold winter temperatures, Grey County was experiencing cracking in roads with conventional asphalt mixes. They found that rubberized asphalt allowed the pavement to be more flexible and therefore reduce cracking. This in turn extends the life of the pavement by an estimated 20 percent. Shaw has received several provincial and international awards for his work, and Grey County has hosted delegations from around the world to view their rubberized asphalt roads.

Warm asphalt mix technology will also be featured as a trial in the Highway 15 contract. Evotherm, one of several Warm Mix technologies, uses an additive and a high asphalt cement residue emulsion to produce asphalt mix at temperatures lower than those used to produce traditional Hot Mix Asphalt. Warm asphalt is produced at temperatures up to 50° C lower than HMA, uses less energy and releases fewer emissions during mix production. For more information on Warm Asphalt Mix, see the article "Warm Asphalt Mix" in the Summer 2007 issue of Road Talk.

Binder lifts for warm asphalt mix trials were placed in Fall 2007, and MTO looks forward to the placement of the remaining warm mix and two rubber trials in the coming construction season. Future tests will continue to assess the costs and benefits of rubberized asphalt and warm mix asphalt on Ontario's roads and highways. ●

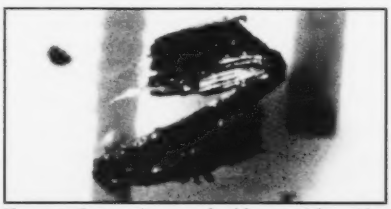


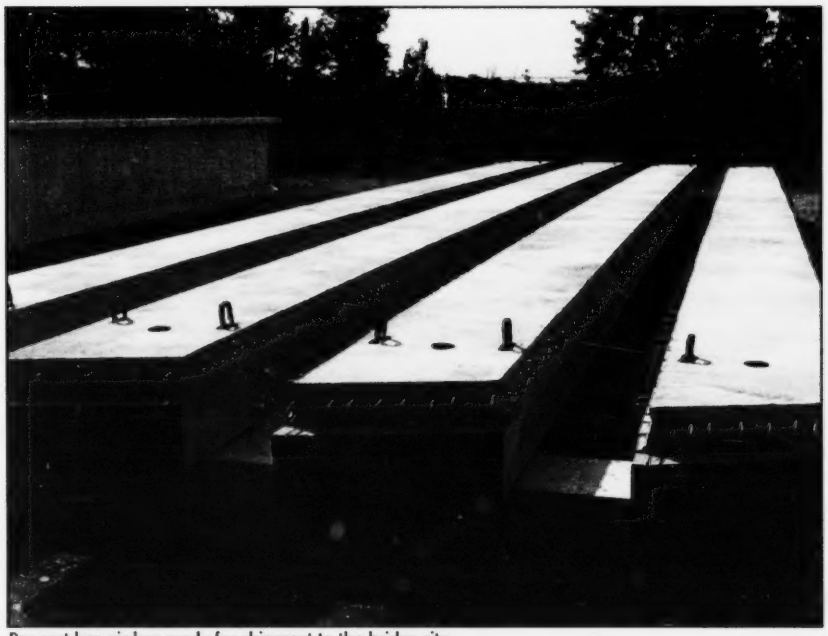
Figure 1: Cryogenic ground rubber particles with clean, smooth surfaces.

Figure 2: Ambient ground rubber particles with rough, gnarled surfaces.

For more information, contact Pamela Marks, Senior Bituminous Engineer, Highway Standards Branch, at (416) 235-3724 or Pamela.Marks@ontario.ca

For more information on Grey County's use of rubber asphalt, contact Gary Shaw, Director of Grey County Transportation and Public Safety, at 519-376-7337 or gshaw@greycounty.ca

"No Time To Wait? Prefabricate!" Sucker Creek Pre-Cast Bridge



Pre-cast box girders ready for shipment to the bridge site.

As part of its commitment to context sensitive design and improved operations, MTO is constantly looking at the potential of new technology in improving bridge construction and increasing bridge lifespan. Rapid replacement and prefabrication technology have spared MTO millions of dollars and years in construction time in the building of bridges across Ontario. Pilot projects involving the use of prefabrication technologies have many benefits: they allow MTO to seek the advancement of industry knowledge, simplify construction, and significantly reduce road closure time. Sucker Creek (formerly Napanee) Bridge in Eastern Region on County Road 41 was substituted using prefabrication technology during the 2005-2006 construction season.

Prefabrication technology has been used successfully in a number of bridge replacement projects throughout Ontario over the past two years, and MTO's Highway Standards Branch has assembled a multidisciplinary team to promote the implementation of these bridges across the province. Prefabricated bridges minimize traffic impact, improve construction zone safety, lower lifecycle costs, and make construction less disruptive for the environment. Because work can be done ahead of time in a controlled environment, prefabricated bridges also improve the quality control of resulting systems. A related construction staging technique is rapid replacement, wherein a new bridge is fabricated nearby in a staging area. Immediately after the original bridge has been torn down, the prefabricated structure is carried to the site using a Self Propelled Modular Transporter (SPMT) and installed. MTO used rapid replacement technology last year to replace a bridge on Ottawa Queensway. For more information on prefabricated bridges and rapid replacement technology, see the article "Island Park Bridges Rapid Replacement" in the Summer 2007 issue of Road Talk.

In the Sucker Creek project, fifty pre-cast box girders with non-shrink grout shear keys were used for the bridge superstructure. No leveling concrete was placed on top of the prefabricated elements. Instead, waterproofing and asphalt mix was laid directly on the deck top to form the roadway pavement.

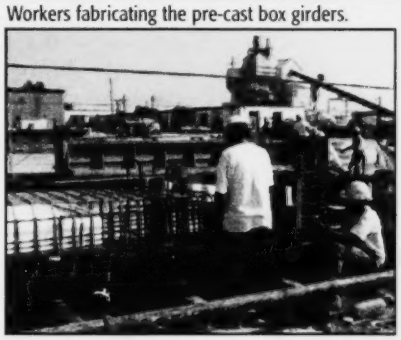
The use of prefabrication technology at the Sucker Creek Bridge site was successful, demonstrating that prefabrication is a viable technology. However, through the process of trial and error, key lessons regarding the process have been learned. Appropriate time management proved to be an unfortunate challenge with the Sucker Creek project. The original schedule indicated completion of the bridge by mid September 2005. However, construction was slow because the contractor was cautious about prefabrication techniques and subsequently did not take advantage of many time saving opportunities. Only the first stage could be completed before the job was closed down for winter. Additionally, there were a number of technical and construction details that could be improved to avoid the delay in construction time. Under normal circumstances, bridge prefabrication reduces project times down from two construction seasons to 2.5 months.

There are currently over fifty bridges in Ontario at various stages of design that have been identified as possible candidates for future prefabrication. In the future, MTO will consider the possibility of prefabricating not only the bridge deck panels and different types of girders, but substructure elements and approach slabs as well.

Watch future issues of Road Talk for information on additional bridge prefabrication projects. •

For more information about the Sucker Creek Bridge, contact Boris Mihov, Project Engineer, Structural, Eastern Region, at (613)545-4716 or Boris.Mihov@Ontario.ca

Workers fabricating the pre-cast box girders.



MTO Tests Alternate Plow Blade Designs

Snow removal is a vitally important component of MTO's winter maintenance toolkit. Effective plowing improves winter driving conditions and reduces the amount of road salt needed for winter operations. Consequently, air blade plows, tow plows, and dual-blade plows have all been recently tested on Ontario's roads and highways, with the aim of effectively combating winter nuisances.

The air blade plow was conceived of as a way to plow more effectively over uneven road surfaces, such as cracks and wheel ruts which are not cleared by conventional, rigid-blade plows. MTO constructed a prototype air blade plow by drilling air holes into a standard carbide plow blade; air nozzles were machined out, a manifold was added, and the blade was hooked up to an air compressor. When activated, compressed air was blown onto the pavement, breaking up packed snow in wheel tracks. An initial trial, carried out by MTO on a stretch of Highway 599 near Ignace, suggested that the air blade was better than the traditional plow at removing packed snow, leaving no residual snow behind. Unlike traditional plows, the air blade plow was also capable of cleaning sand and water. A full winter test of the technology has not yet been conducted, but it has many potential benefits. MTO hopes that the design will reduce wear to both plow blades and to pavement, and offer improved performance over standard plows. Because its operating speed is currently restricted by the need for a very large volume of air, the air blade plow is currently being redesigned. This redesign involves relocating the air blade behind a traditional steel blade, thus allowing the conventional blade to move the bulk of snow while the air blade removes residue. If the air blade plow can be made to operate at highway speeds, the next step would be a full winter test.

The Two Stage blade features a smaller trailing blade with flexible segments that clean off loose snow and clear slush.

The Tow Plow is a full-length, trailer-mounted plow blade, capable of clearing multiple lanes of traffic. It operates as a side-wing with two in-cab controls that create a 25-foot clearing path, with a 12-foot front plow. One control works to lift and lower the blade, while the other control steers the rear axle and swivel tongues. The Tow Plow offers similar functionality to a truck with a wing blade (multi-lane, high-speed plowing), but covers more width, is easier to drive, and offers improved visibility. The technology was tested on Highway 401 in 2006 and on Highway 407 ETR in 2007. Manufacturer Viking-Cives claims that the Tow Plow is both cost-effective and safe: by doing the work of two plows, the Tow Plow could conceivably reduce the number of plows on the road while improving the safety of Ontario's motorists.

MTO has also conducted tests on a dual-blade plow design, Viking-Cives' Two Stage blade. This dual-blade plow consists of a standard front steel blade and a smaller trailing blade with flexible segments designed to clean off loose snow scraped up by the leading blade and to clear slush that a conventional blade cannot reach. Trials were conducted on stretches of Highway 6, north of Mount Forest, in Winter 2007. Although operators expressed concern over noise and the durability of the secondary blade's flexible "teeth", MTO trials showed that the Two Stage blade was better than conventional plow blades at removing packed snow. Viking-Cives claims that their dual-blade design improves driver safety and reduces the number of snow removal trips required. Evaluations have recommended the limited adoption of the Two Stage blade in additional locations, with performance to be closely monitored.

MTO remains committed to monitoring and implementing new developments in snow removal technology that allow for safer, faster, and more effective plowing. Watch future issues of Road Talk for the results of further testing involving the Tow Plow, dual blade, and air blade plow designs. ●

The air blade plow is also capable of cleaning sand and water.

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Quiet, Please: Noise Reduction Pavement

Chronic exposure to unwanted noise can lead to stress, hearing loss, and hypertension. Studies show that roadway noise is a primary contributor to noise pollution, which also interferes with the role of sound in animal reproduction, navigation, and predator/prey detection and avoidance. MTO is committed to minimizing the impact of roadway noise and has scheduled trials of noise reduction pavement on a stretch of Highway 405 from QEW to Queenston Plaza in Central Region.

Traffic noise comes from three major sources: the power train (from the engine and exhaust system), coast-by noise or aerodynamic noise, and tire/pavement noise. At speeds of over 50 km/h, tire and pavement noise dominate, meaning that pavement selection can play a significant role in noise reduction. Ontario's Environmental Assessment Act requires MTO to predict possible environmental impacts from construction and highway traffic generated noise, and to define actions necessary to mitigate these.

The human ear's response to sound is usually measured in decibels (dBA). 0 dBA is the hearing threshold, and an increase of 10 dBA corresponds to an approximate doubling of the noise level. Conversation, for example, occurs at approximately 50 dBA, the sound of trains at 90 dBA, and chainsaws at 100 dBA. Discomfort begins at approximately 70 dBA. For proposed highway construction projects, MTO recommends a reduction in noise level to as close to 55 dBA as possible. A reduction of 5 dBA has the same effect as doubling the hearer's distance from a noise source. Studies show that, depending on the type of pavement used, quiet pavement can reduce noise by 1 to 9 dBA.

Noise abatement barriers are a traditional way to reduce noise pollution. While noise barriers are currently considered the most effective method of noise abatement, they are expensive and effective only for those in line-of-sight; they do nothing to reduce noise at its source. Noise barriers are only effective to a distance of 100 to 150 m. Beyond this, noise is the same with or without barriers in place.

Controlling surface texture via quiet pavement is an alternative method of noise mitigation. Open graded asphalt with a porous surface and an internal matrix (including MTO's Open Friction Course) offers significant noise reduction, reduced tire splash, and potential cost savings due to thinner lifts and the elimination or reduction of noise walls. Unfortunately, it has a shorter pavement life, higher construction costs, and higher maintenance costs than traditional Hot Mix Asphalt (HMA). Open friction asphalt requires more frequent salting, more salt quantity, and greater plowing effort. Winter maintenance clogs open friction asphalt with sand, reducing its effectiveness. Quiet pavement can also include Porous Friction Course, Two-layer Porous Asphalt, and Fine Graded Stone Mastic Asphalt (SMA).

Porous Friction Course offers 3-5 dBA of noise reduction and an 8-to-12 year life. Two-layer Porous Asphalt consists of a thin lift (20-30 mm) of fine graded porous surface course over 40-50 mm of binder course. European studies show that two-layer Porous Asphalt is approximately 4-9 dBA quieter than traditional pavement, but has a pavement life of only seven years. Fine Graded SMA is less permeable and more durable than other quiet pavements, but offers only approximately 1 dBA of noise reduction. In addition, fine grading allows thinner lift thickness, and SMA's expected life is comparable to traditional dense graded asphalt.

A number of jurisdictions have already experimented with quiet pavement. Since the early 1980s, countries in Europe found that 9 dBA in noise reduction can be realized from two-layer systems. Locally, the University of Waterloo's Centre for Pavement and Transportation Technology (CPATT) has initiated quiet pavement trials in the Regional Municipality of Waterloo, and York Region has begun a trial of fine graded (9.5 mm) SMA.

MTO's quiet pavement trial will consist of four test sections and one control section. The control section will be a Superpave 12.5 FC2 over Superpave 19.0, while the four test sections will be constructed as follows:

Trials will test the efficacy of quiet pavement on Ontario's highways.

- Section 1: 30 mm Open Friction Course over 50 mm Open Binder Course (two-layer system)
- Section 2: 30 mm Open Friction Course over 50 mm Superpave 19.0
- Section 3: 30 mm Open Friction Course with rubberized asphalt over 50 mm Superpave 19.0
- Section 4: 30 mm SMA 9.5 over 50 mm Superpave 19.0

MTO will monitor performance and noise reduction over a five-year period. Trials will determine whether quiet pavement has long-term acoustic and structural integrity, and which type of quiet pavement offers the best combination of noise mitigation and durability. MTO will use results to generate recommendations regarding the potential benefits of noise reduction pavement. •

For more information, contact Kai Tam, Manager, Bituminous Section, Highway Standards Branch, at (416) 235-3725 or Kai.Tam@ontario.ca

Upcoming Conference Information

2008 FHWA Acclerated Bridge Construction Conference
March 20-21, 2008
Baltimore, Maryland

Highway Economic Requirements Modeling and Data Integration Conference
April 8-9, 2008
Irvine, California

National Roundabout Conference
May 18-21, 2008
Kansas City, Missouri

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The human ear's response to sound is usually measured in decibels (dBA). 0 dBA is the hearing threshold, and an increase of 10 dBA corresponds to an approximate doubling of the noise level. Conversation, for example, occurs at approximately 50 dBA, the sound of trains at 90 dBA, and chainsaws at 100 dBA. Discomfort begins at approximately 70 dBA. For proposed highway construction projects, MTO recommends a reduction in noise level to as close to 55 dBA as possible. A reduction of 5 dBA has the same effect as doubling the hearer's distance from a noise source. Studies show that, depending on the type of pavement used, quiet pavement can reduce noise by 1 to 9 dBA.

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Read All About It!

MTO Tests Deer Reflectors on Highway 540

Every year deer-vehicle collisions on provincial highways result in lost lives, millions of dollars of vehicle damage, and traffic delays. Between 2001 and 2005, there were 6,739 reported deer-vehicle collisions in Northeastern Ontario[1]. A steady increase in the number of reported collisions has become a mounting concern for Ontario drivers.

To help address this problem, the MTO began a pilot project in late August 2007 to test the effectiveness of highway reflectors that are designed to discourage deer from crossing into oncoming traffic.

MTO is testing the Wild Animal Highway Warning Reflector System, developed by US-based company Strieter-Lite®. The reflector system has previously been used in Quebec, Saskatchewan and British Columbia.

The trial area in Northeastern Ontario is a section of Highway 540 on Manitoulin Island, heading east from Pleasant Valley Road for 800 metres. MTO selected this particular stretch of highway because of its history of deer-vehicle collisions.

MTO's implementation of the Strieter-Lite® system includes reflector posts that are staggered on both sides of the road at 10 m intervals. Each reflector consists of a face with 70 small curved mirrors, which reflect headlight glare between dusk and dawn when deer are most active. As a vehicle approaches, headlight glare intensifies, and is reflected by the posts, which alert deer to danger. The strobe light-like effect, produced by headlights "bouncing" between the staggered reflectors, appears to be an object moving in advance of a vehicle. The manufacturer says that deer draw an association between the moving light and the sound of oncoming traffic, discouraging them from crossing the road until the vehicles have passed. Reflected light from the posts never reaches the driver's eye, so motorists are not distracted. Unfortunately, the reflector posts are ineffective during daylight hours when motorists do not have headlights turned on, and they are not known to deter moose or other wildlife.

Strieter-Lite deer reflectors are being tested on an 800m stretch of Highway 540.

Wild Animal Highway Warning Reflector Systems installed along Ontario's highways have a number of possible benefits. Strieter-Lite® claims that their deer reflectors provide enhanced safety for motorists, a reduction in the number of road-killed animals, and increased savings when compared to the cost of wildlife fencing. As part of the pilot project, MTO will monitor the effectiveness of the technology by conducting field studies and examining collision statistics.

In addition to the reflector pilot, MTO continues to monitor other recent initiatives aimed at reducing wildlife-vehicle collisions, including specially designed wildlife fencing along the highway right-of-way, wildlife crossings/culverts, and enhanced wildlife warning signage. ●

For more information, contact Marlo Johnson, Head of Planning and Environmental, Northeastern Region, at (705)497-5458 or Marlo.Johnson@Ontario.ca

[1] NER Wildlife Collisions Spreadsheet.

Reader Response

Please help Road Talk become more effective

Send us any ideas, comments, or suggestions concerning local innovations, workshops, or seminars that you would like to see included in future issues.

Road Talk is also available in French.

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